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RESEARCH NOTE

Life history and host fish identification for *Fusconaia burkei* and *Pleurobema strodeanum* (Bivalvia: Unionidae)

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Abstract: We documented the period of gravidity, identified the fish host, and described the glochidia for two mussel species, *Fusconaia burkei* (Wright, 1898) and *Pleurobema strodeanum* Walker, 1922, in Eightmile Creek, Walton County, Florida. Populations of both species were checked monthly from December 2003 to October 2004 and were found to be gravid from the middle of March to late May. The size and shape of *F. burkei* and *P. strodeanum* glochidia were similar. Conglutinates released by *F. burkei* were pink-colored and cylindrical in shape, tapering sharply on both ends. *Pleurobema strodeanum* conglutinates were creamy or peach-colored and wider with a more flattened appearance than those of *F. burkei*. Ten potential host fish species were exposed to either *F. burkei* or *P. strodeanum* glochidia. We identified the blacktail shiner (*Cyprinella venusta*) as a host fish species for both *F. burkei* and *P. strodeanum*.

Key words: gravidity, glochidia, juveniles, freshwater mussels, Choctawhatchee River

North America possesses a rich freshwater mussel (Bivalvia: Unionidae) fauna, but this group is in rapid decline. Within the Conecuh-Escambia, Yellow, and Choctawhatchee River basins of Alabama and Florida, freshwater mussel populations have experienced recent declines in species richness and relative abundance (Blalock-Herod *et al.* 2005, Pilarczyk *et al.* 2006), resulting in the recent elevation of eight mussel species to candidate status under the Endangered Species Act (U.S. Fish and Wildlife Service 2004). Life history information is crucial for assessing population viability and evaluating conservation needs of this declining fauna (U.S. Fish and Wildlife Service 2003). However, host fish information has been reported for only one quarter of the mussel species in North America (Hoggarth 1992), and other life history information is also lacking for most species.

The tapered pigtoe (*Fusconaia burkei* (Wright, 1898), formerly referred to as *Quincuncina burkei* Wright, 1898) is a small mussel endemic to the Choctawhatchee River basin (Williams and Butler 1994). The fuzzy pigtoe (*Pleurobema strodeanum* Walker, 1922) is native to the Conecuh-Escambia, Yellow, and Choctawhatchee River drainages in Alabama and Florida (Clench and Turner 1956). Both of these species are candidates for protection under the Endangered Species Act, and host fish and life history information for both species are unknown. The objectives of this study were to assess the life history and host use of the tapered pigtoe and the fuzzy pigtoe in order to provide data for conservation and management decisions.

We studied both species in Eightmile Creek, Walton County, Florida, ~14.5 km east southeast of Florala, Alabama (Fig. 1). Eightmile Creek is a tributary of the Pea River (Choctawhatchee River drainage) and lies within the Southeastern Plains level III ecoregion (Griffith *et al.* 2001). At the study site, Eightmile Creek is moderately to highly sinuous, with primarily sandy substrates, a wide riparian zone, and stable, well-vegetated stream banks. Water samples from Eightmile Creek were taken monthly for 10 months. Stream water was tea-colored, as a result of natural tannins, with a mean dissolved oxygen of 7.2 mg/L (SD = 1.6) and mean pH of 7.0 (SD = 0.7). Mean turbidity was 1.9 NTU (SD = 0.9), and water temperature ranged from 11 to 24°C throughout the year. The creek supports a fish community of at least twenty species as well as populations of at least eight freshwater mussel species, including *Fusconaia burkei* and *Pleurobema strodeanum* (Pilarczyk *et al.* 2006).

Eightmile Creek was checked monthly from December 2003 to October 2004 for gravid mussels, except June 2004 because of high water levels. On each date, we tagged all *Fusconaia burkei* or *Pleurobema strodeanum* using numbered Floy® shellfish tags. Voucher specimens of both species were collected, preserved in 70% ethanol, and deposited in the Troy University collection.

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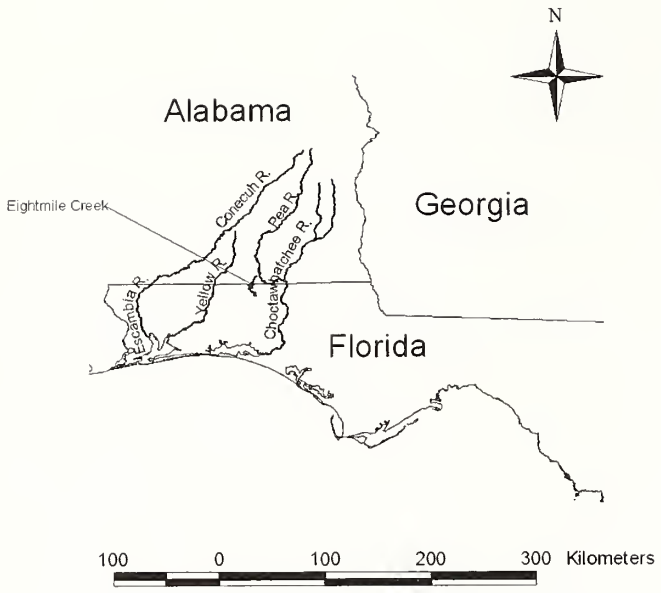

Figure 1. Study site at Eightmile Creek, Walton County, Florida.

Mussels were checked for the presence of embryos by carefully prying open the shell to inspect the gills for any inflation or color change that would indicate a gravid female. Some gravid females were transported to the laboratory to release glochidia. These mussels were individually bagged in plastic sandwich bags with stream water and transported in coolers to reduce stress and abortion of glochidia. Mussels were held at room temperature (about 22°C) in individual beakers covered with 105-μm mesh screening in an aerated aquarium containing filtered water from the study site. After glochidia were expelled, the adult mussels were returned to the collection site at Eightmile Creek.

We collected fishes for host trials using a backpack electrofisher in streams within the same watershed as Eightmile Creek where no *Fusconaia burkei* or *Pleurobema strodeanum* were present to reduce the likelihood that the fish had acquired immunity via a previous infection to the glochidia of these two species (Arey 1923, Rogers and Dimock 2003). All fishes used in host trials have been found in Eightmile Creek, with the exception of the blacktip shiner (*Lythrurus atrapiculus*), a cyprinid that occurs within the native range of the target mussel species (Mettee *et al.* 1996). Fish were transported to the laboratory in an aerated cooler and held in tanks for at least one to two weeks prior to conducting experiments to allow acclimation to the laboratory, and to slough off any residual glochidial infection.

Methods to infect fish with glochidia followed those described by O'Brien and Williams (2002). Once conglutinates were released in the laboratory, they were gently agitated to release the glochidia. Glochidial viability was checked by exposing a subsample of glochidia to NaCl. Glochidia were considered viable, and used in host fish trials, if more than 50% of the subsample snapped shut in response to the NaCl. Fishes from four families and six species were exposed to *Fusconaia burkei* glochidia over the course of 10 trials. Over the course of 20 trials, fishes from six families and 10 species were exposed to *Pleurobema strodeanum* glochidia.

After fishes were infected, each species was held individually in covered aerated beakers in a water bath at about 22°C. Every three days, the water from the beakers was sieved through a 105-μm mesh screen, and filtered material was examined under a microscope for juvenile mussels. Transformed juveniles were identified by foot movement and the presence of two adductor muscles, while untransformed glochidia were motionless and had only one adductor muscle (Karna and Millemann 1978). Once juveniles were found, the water was sieved daily. These daily checks continued for 10 days after the last juvenile was found (O'Brien and Williams 2002). If no juveniles were found after five weeks, the trial was ended. Host fish were considered those that successfully allowed the transformation of glochidia into juvenile mussels. Fish that did not produce juveniles were preserved after trials and examined under a microscope for evidence of encysted glochidia.

Several conglutinates from each species were preserved in 70% ethanol for description. We measured total length and maximum width of conglutinates to the nearest 0.01 mm for both species, using an ocular micrometer. We also measured valve length, height, and hinge length of glochidia following Hoggarth (1999). Length was measured as the maximum distance from anterior to posterior margins, and measurements were made parallel to the hinge. Height was measured as the maximum distance from dorsal to ventral margins, and measurements were made perpendicular to

Table 1. Percent gravid mussels for *Fusconaia burkei* and *Pleurobema strodeanum* out of total number of mussels of each species checked at Eightmile Creek, Florida (*, very high water level).

Date	Water temperature (°C)	*Fusconaia burkei* %	(*N*)	*Pleurobema strodeanum* %	(*N*)
12/18/2003	not recorded	0.0	(8)	0.0	(21)
1/27/2004	13.4	0.0	(5)	0.0	(21)
2/10/2004*	11.0	—	(0)	0.0	(4)
3/16/2004	17.7	25.0	(4)	53.3	(30)
3/30/2004	17.3	66.7	(9)	22.0	(41)
4/21/2004	18.3	0.0	(3)	23.8	(42)
5/27/2004	20.8	13.6	(22)	26.8	(97)
7/26/2004	23.6	0.0	(4)	0.0	(19)
8/27/2004	24.1	0.0	(8)	0.0	(24)
10/19/2004	19.6	0.0	(6)	0.0	(22)

Table 2. Fish species used, number of individuals used, trial duration (days), reason trial was ended (J, ten days after the last juvenile was detected; T, trial terminated after no juveniles were detected for five weeks; X, all fish died), and number of juveniles produced for each of the ten host fish trials performed for *Fusconaia burkei* and *Pleurobema strodeanum*.

Fish families and species	Individuals	Duration (days)	Reason trial ended	Juveniles
		Fusconaia burkei		
Centrarchidae				
Lepomis macrochirus	2	37	T	0
Lepomis macrochirus	3	10	X	0
Cyprinidae				
Cyprinella venusta	4	19	X	0
Cyprinella venusta	3	32	J	35
Notropis texanus	3	35	T	0
Notropis texanus	3	8	X	0
Pteronotropis hypselopterus	1	12	X	0
Fundulidae				
Fundulus olivaceus	3	37	T	0
Fundulus olivaceus	3	34	T	0
Ictaluridae				
Noturus leptacanthus	1	8	X	0
		Pleurobema strodeanum		
Aphredoderidae				
Aphredoderus sayanus	1	36	T	0
Centrarchidae				
Lepomis macrochirus	3	7	X	0
Cyprinidae				
Cyprinella venusta	3	6	X	0
Cyprinella venusta	1	27	J	84
Cyprinella venusta	1	13	X	17
Cyprinella venusta	1	16	X	71
Cyprinella venusta	1	29	J	56
Lythrurus atrapiculus	2	3	X	0
Notropis texanus	3	28	X	0
Notropis texanus	3	12	X	0
Notropis texanus	4	6	X	0
Notropis texanus	3	2	X	0
Pteronotropis hypselopterus	1	34	T	0
Fundulidae				
Fundulus olivaceus	3	4	X	0
Fundulus olivaceus	3	12	X	0
Ictaluridae				
Noturus leptacanthus	2	34	T	0
Noturus leptacanthus	1	36	T	0
Percidae				
Etheostoma edwini	1	34	T	0
Percina nigrofasciata	2	10	X	0
Percina nigrofasciata	1	11	X	0

length. Hinge length was measured in a straight line from the points at which the dorsal margins intersect the anterior and posterior margins. Student's *t*-tests were used to compare valve length, height, and hinge length between the two species. Other characteristics we examined were valve shape and hook presence or absence.

We tagged and examined a total of 32 *Fusconaia burkei* and 161 *Pleurobema strodeanum*. Gravid specimens of both species were found at Eightmile Creek between March 16 and May 27, 2004, indicating these species are short-term brooders, or tachytictic (Table 1). The peak period of gravidity was late March for *F. burkei* and mid-March for *P. strodeanum* (Table 1). Mean water temperature during the period in which female mussels were gravid was 18.0°C (range: 15.8-20.8°C). There was no evidence that females of either species produced multiple clutches in a year. Both species often released conglutinates within the first 24 hours following the gravidity check, indicating that handling may result in premature abortion of glochidia. While many glochidia were viable, unnecessary evaluations of gravidity should be avoided to reduce the likelihood of abortion, especially for candidate, threatened, or endangered species.

Both the inner and outer demibranchs of gravid *Fusconaia burkei* were slightly inflated and typically had a pinkish color. In the laboratory, nine *F. burkei* released pink-colored conglutinates from March 31 to April 12, 2004. Five of the nine individuals released conglutinates on only one occasion. However, the other four *F. burkei* had two to four conglutinate releases over the course of two to eight days.

Only the outer demibranchs of the gills of gravid *Pleurobema strodeanum* were inflated and had a creamy-orange color. Twenty-three *P. strodeanum* released cream-colored conglutinates in the laboratory from March 19 to April 29, 2004. The number of conglutinate releases per *P. strodeanum* individual ranged from one to four, with about half of the individuals releasing conglutinates only once. Eleven *P. strodeanum* had two to four conglutinate releases over the course of three to 12 days.

Fusconaia burkei released slender, pink-colored conglutinates that were cylindrical in shape and tapered to only one or two glochidia on both ends. *Fusconaia burkei* conglutinates measured about 1 × 6.5 mm. Conglutinates released by *Pleurobema strodeanum* were creamy or peach-colored, had a more flattened appearance, and were much wider than those of *F. burkei*. *Pleurobema strodeanum* conglutinates were also tapered, though not as narrowly as those of *F. burkei*, at both ends. *Pleurobema strodeanum* conglutinates were about 2 × 8 mm.

The size and shape of both species' glochidia were similar and not easily distinguishable. The mean valve height for *Fusconaia burkei* glochidia was 160.1 µm (SD = 6.8, n = 5), mean valve length was 167.3 µm (SD = 4.3, n = 5), and mean hinge length was 130.6 µm (SD = 5.8, n = 5). For *Pleurobema strodeanum* glochidia, mean valve height was 166.3 µm (SD = 2.8, n = 5), mean valve length was 176.5 µm (SD = 2.8, n = 5), and mean hinge length was 126.5 µm (SD = 2.3, n = 5). While there was no statistically significant difference in valve height (Student's t-test, t = −1.85, P = 0.10) and hinge length (t = 1.46, P = 0.18) between the two species, the valve length of *P. strodeanum* glochidia was significantly greater than that of *F. burkei* (t = −4.02, P = 0.004). The glochidial hook was absent in both *F. burkei* and *P. strodeanum*, and both species had a subelliptical valve shape.

Of the 10 host fish trials performed for *Fusconaia burkei*, only one produced juveniles (Table 2). Twenty-one days after exposure to glochidia, juveniles were found in the sieved water of *Cyprinella venusta*. This trial, the second attempt to infect *C. venusta* with *F. burkei* glochidia, resulted in the transformation of 35 glochidia into juveniles. Some juveniles were kept alive in the laboratory for at least six weeks.

Pleurobema strodeanum glochidia transformed into juveniles in four of the 20 trials (Table 2), but only on *Cyprinella venusta* individuals. A mean of 14 days from date of infection elapsed until the first transformed *P. strodeanum* juvenile was collected. The first successful trial produced 84 juveniles: 50 collected on day 15, 32 on day 16, and two on day 17. The second successful trial produced 17 juveniles on day 13, but the fish subsequently died, and no additional juveniles were collected. The third trial produced 71 juveniles: 46 collected on day 14 and 25 on day 15. The fish died on day 15, and no additional juveniles were collected. The fourth successful trial yielded 56 juveniles: six collected on day 14, 46 on day 16, and four were collected on day 18. Some juveniles from these trials were kept alive in the laboratory for over nine weeks. When fishes that did not produce juveniles were preserved and later examined, no encysted glochidia were observed on the gills or fins.

The period of gravidity documented in this study for both species is supported by existing literature. Ortmann and Walker (1922) reported a gravid female *Fusconaia burkei* at the Choctawhatchee River, Alabama, in May. Gravid *Pleurobema strodeanum* have been found at the Choctawhatchee River, Florida, during April and in the Escambia River drainage in July (H. N. Blalock-Herod, unpubl. data). Gravid females of a closely related species, *Pleurobema pyriforme* (Lea, 1857), were reported from March to July at Chickasawhatchee and Kinchafoonee Creeks in the Apalachicola, Chattahoochee and Flint Rivers Drainage (O'Brien and Williams 2002).

The successful transformation of *Fusconaia burkei* and *Pleurobema strodeanum* glochidia on *Cyprinella venusta* is also consistent with the existing literature on related taxa. *Fusconaia* typically use Cyprinidae as fish hosts. Haag and Warren (2003) reported that schools of *C. venusta* repeatedly interacted with drifting conglutinates from the related taxa *Fusconaia cerina* (Conrad, 1838) and *Pleurobema decisum* (Lea, 1831). Host fish trials resulted in *Fusconaia cerina* glochidia transforming on a wide variety of cyprinid species, including *C. venusta*; *P. decisum* glochidia also transformed consistently on *C. venusta* (Haag and Warren 2003). Additional studies confirmed that cyprinids often serve as hosts for *Pleurobema* (Haag and Warren 1997, O'Brien and Williams 2002, Layzer *et al.* 2003). The data collected in the current study will be useful in determining and implementing conservation actions for the protection of these rare mussel species.

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